

Study of the Change in Export Competitive Advantage of Japan, China, South Korea and Taiwan in the US Market – Using RCA as the Measurement Index

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ABSTRACT

The main purpose of the study is to explore the change in export competitive advantage of Japan, China, South Korea and Taiwan in the US market and to study whether the structure of export industry is changing in each country, by using the two-digit industries as the basis for analysis, and the every three-year average variation of revealed comparative advantage (RCA) to understand the enhancement rate and reducing rate of comparative advantage of industrial export. Thus, whether the change in export competitive advantage was related to the shifting of comparative advantage between areas was analyzed by using the RCA correlation coefficients for each country. Finally, the size of change in export industry structure and whether each country was following the development of or competing with each other, was explored using the RCA correlation coefficients for each country. The research concluded the demonstration of significant positive correlation between South Korea and Taiwan's export products to the US, while the pattern of Taiwan's export products to the US followed Japan, but not at the same pace as Japan yet, and the pattern of China's export products to the US followed Taiwan's route of development closely to move forward.

Keywords: *Competitive Advantages, HS (Harmonized System Code), Revealed Comparative Advantage (RCA Index)*

INTRODUCTION

Taiwan is an island-type economic entity where exports contribute to Taiwan's economic growth at a very large ratio. However, the 2008 financial tsunami has caused the mainly international market-oriented Taiwan economy to suffer greatly, plus the rapid export growth of Mainland China in recent years, and the growth of GDP per capital in South Korea in recent years that even surpassed Taiwan have all played a role. In addition, according to the flying-geese model, whether Japan's export products to the US were to a certain degree replaced by Taiwan and South Korea's, and South Korea and Taiwan's were to a certain degree replaced by Mainland China's, or Japan, China, South Korea and Taiwan's export products to the US market are exhibiting competitiveness concurrently, or even whether the export industry structure in each country was changed is still open to analysis. In the ever-changing international environment, the understanding of the situation of Japan, China, South Korea, and Taiwan's exports to the US to upgrade Taiwan's competitiveness is an important issue.

This study first calculated the export to the US market from 1996 to 2007 for Japan, China, South Korea, and Taiwan's HS (Harmonized System Code) two-digit industry (total of 98) categories. It uses the every three-year average variation of "Revealed Comparative Advantage, RCA" to understand the enhancement and reducing rates of comparative advantage of industrial exports; further analyzes the changes in export competitive advantage to be the industry of competition or shifting market between each country by RCA correlation coefficients; finally, by using the RCA correlation coefficients to explore the export competitive advantage development model, it determines the scale of changes in industrial structure in the same area, and whether the correlation of the development model in different areas as follows development or is in competition with each other. The study expects to realize the industrial structure changes the development model, and the ups and downs of industrial competitiveness for Japan, China, South Korea, and Taiwan's exports to the US market.

LITERATURE REVIEW

In the theory of export comparative advantage, the export market share theory only considers each industry's export market share without any consideration of the economic scale of each country, while the RCA index which was earliest used in 1965 by Balassa for international comparative advantage analysis, holds that comparative advantage can be demonstrated by the observed trade model (Balassa, 1965). It has the advantage of taking each country's economic scale into account for each industry's export market share that enables the use of the same index to represent the comparative competitiveness of the same product between each country or of different products in the same country. Its disadvantage is the inability to distinguish the effect of natural factors or trade policies, but it provides the index for the shifting of regional comparative advantage.

A considerable amount of literature has adopted the RCA index for the study of national comparative advantage, some examples are as follows: Liu Pang-Tien and Chien Chen-Lin (1988) took market share, RCA index and constant market share for the analysis of Taiwan's manufacturing industry export competitiveness to OECD (Organization of Economic Corporation Development) and found Taiwan's manufacturing industry export competitiveness to rank first among the four little tigers of Asia, and Mainland China's export competitiveness was higher than Indonesia and Thailand, while Taiwan and South Korea's export competitiveness in the OECD market was close. Leu (1998) selected the RCA index of 10 East-Asian economic entities' exports to the US market to compare the correlation coefficients between countries and at different periods in the same country to understand the dynamic changes in each country's export model. Ching Hsin-tsu (2000) calculated the RCA for Taiwan and five ASEAN countries' industries of export to US to explore their comparative competitiveness and to check the similarity in competitive structure for each industry in each country by correlation coefficients. Bender and Li (2002) calculated the RCA index for East-Asian economic entities, South-East Asian countries and Latin American countries to explore the shifting of comparative advantage between the three regions, while this study uses the correlation coefficients between industries to analyze whether the changes in export model were correlated with regional comparative advantage shifting – to explore the industries of competition or shifting market for Japan, China, South Korea, and Taiwan's exports to US markets. Lee (2003) used the RCA index to inspect the export comparative advantage for Canada and another 31 countries and found Canadian industries to become sector-professionalized. Diarmaid (2005) applied RCA index and variation rate to explore the changes in comparative advantage for each industry from 1997 to 2005 in Ireland. Clark, Sawyer, Charles and Spinkle (2005) divided the US into 8 regions and used the production and export data of each region to calculate the correlation coefficients of RCA for the same region from 1987 to 2000. If the correlation coefficient is high, it represents the industrial structure becomes smaller; if the correlation coefficient is low, it represents the industrial structure becomes larger.

This study analyzes the RCA correlation coefficients of Taiwan, Mainland China, South Korea, and Japan's export to the US from 1996 to 2007, to understand the correlation between export structure of these countries in the same period and in different periods by further analysis correlation coefficients between countries in the same period and in different periods. In addition, the study reviewed literature regarding changes in the ranking of a country's comparative advantage due to joining regional trade groups. Wu Chia-hsun and Hsu Shih-hsun (2004) applied the RCA index to conduct the comparative analysis of worldwide and bilateral export competitiveness for Taiwan, New Zealand and Australia; Utkulu and Seymen (2004) used nine different types of RCA measurement method as the basis, and used the correlation coefficients to test Turkey's exports to the European economic entity from 1990 to 2003 to see whether customs' unions had any significant comparative advantage and competitive effects on a trade model and to explore the stability of the nine RCA measurement methods. The research results found considerable stability for different RCA measurement methods, and although the RCA index has some short-comings, it provides a useful tool for the inspection of comparative advantage. This study also wishes to provide more information for Taiwan's competitiveness through the RCA index analysis.

Most Taiwan's literature only conducted market competitive analysis or explained the correlation for export comparative advantage products by correlation coefficients, while foreign literature has included the dynamic RCA variation analysis. This study in addition to that, further analyzes the correlation coefficients between different

countries in the same period and in different periods to understand the correlation of export structure model between countries in the same period and in different periods.

METHODOLOGY

Research Methods

Regarding the significance and model of RCA, variation rate and correlation coefficient, function and limitation are explained respectively as follows:

The significance and model of RCA

The Revealed Comparative Advantage (RCA) index means the export market share of i industry (or product) of a country in the world, averaged by that country's total export share of the world's total countries' export.

$$RCA_i = \frac{\sum_j X_{ij}^k}{\sum_j X_{ij}^k} / \frac{\sum_i X_{ij}^k}{\sum_i \sum_j X_{ij}^k} \quad (1)$$

X_{ij}^k : the export value of j country's i industry in k region

$\sum_j X_{ij}^k$: the total import value of i industry in k region

$\sum_i X_{ij}^k$: the total export value of j country in k region

$\sum_i \sum_j X_{ij}^k$: the total import value in k region

Basically, $RCA > 1$ means the share of the importation of i product from j country to k country is greater than the share of importation of k country from j country, i.e. the RCA has taken the trade scale of the exporting country into account. Therefore, the comparative competitiveness of the same product in different countries, or the comparative competitiveness of different products in the same country can be compared using RCA. According to the general definition, the judging of the comparative strength and weakness of export competitiveness of a country's industry can be described as follows: $RCA > 2$ means an industry having extremely strong export competitiveness; while $1 < RCA < 2$ means an industry having strong export competitiveness; and $0.5 < RCA < 1$ means an industry having weak export competitiveness; $RCA < 0.5$ means an industry having extremely weak export competitiveness.

From the changing trends of RCA, the competitiveness of a product can be analyzed as gradually strengthened or steady or degraded. And from each country's correlation coefficient of RCA, it can be expected that whether there is any correlation to the changes of export model in different regions will be understood. Therefore, this study applies the RCA index as the basis for analysis.

The variation rate of RCA value and the correlation coefficient

1. Variation rate

$$RCA_i \text{ variation rate} = (RCA_{it} - RCA_{i0}) / RCA_{i0} \quad (2)$$

RCA_{i0} : the RCA value at period o for i industry

RCA_{it} : the RCA value at period t for i industry

$RCA_{it} - RCA_{i0}$: the variation of RCA value from period o to period t for i industry

If RCA variation rate is a positive figure, it means the strengthening of comparative advantage from period o to period t for i industry; if it is a negative figure, it means the weakening of comparative advantage from period o to period t for i industry.

2. The correlation of RCA value in the same period

From which, whether the change in export model is correlated to the shifting of regional comparative advantage or not, can be explored. This study applies the Clark et al (2005) method if the RCA value becomes smaller in certain regions but becomes larger in other regions, and the correlation coefficient significantly shows the shifting effect of export comparative advantage. If a certain industry in a certain region obtains comparative advantage at the same time,

becomes more competitive, and the correlation coefficient also shows positive correlation, it represents that these industries to a certain degree are competing with each other in these regions.

3. The correlation coefficient of RCA value in different periods

The dynamic changing method of comparative advantage was developed by Kreinin and Plummer (1994), which makes the correlation coefficient by the ranking of RCA value in different periods. If the correlation coefficient is higher, it represents the change in industrial structure is smaller.

Corr. (RCA_0, RCA_t) : the correlation of RCA value from period 0 to period t in the same region or different regions.

- (1) If the correlation coefficient of RCA value from period 0 to period t in the same region is high, it represents the industrial structure change is small from period 0 to period t; conversely, if the correlation coefficient is low, it represents the industrial structure change is large.
- (2) If the correlation coefficient of RCA value from period 0 to period t in different regions is high, it represents the model of comparative advantage development in a certain region is following another region.

The function and limitation of RCA

The advantage of RCA value is to take each country's economic scale into account for each industry's export market share that enables the use of the same index to represent the comparative competitiveness of the same product between each country or of different products in the same country.

However RCA is not a perfect index and has the following shortcomings:

1. The inability to explain RCA improvement due to natural factors or trade policy factors.
2. It is possible that the country's export occupies a very small ratio of the import country, therefore only a small ratio of increase in a certain industry of that country's exports could cause considerable change to the RCA.
3. It contributes the change in export market share completely to the upgrade of competitiveness of the industry itself without discussing other changes in the overall structural factors.

RESULTS OF ANALYSIS OF REAL EVIDENCE

The Exploration of RCA Variation and Analysis of Enhancement Rate and Reducing Rate

The study first explores Japan, China, South Korea and Taiwan's export market share in the US market as well as the number of industries of each scope of the RCA index to understand the situation of trade performance of each country in the US market. Mainland China's export market share in the US has increased the most, from the average of 7.16% in 1996~1998 to the average of 15.5% in 2005~2007, while all three other countries had declining market share. From 1996~2007, the total import growth rate in the US was 146.89%, and 524.01% in Mainland China, 109.94% in South Korea, 28.05% in Taiwan and 26.28% in Japan (Table 1). The growth rate of Mainland China's export to the US is higher than the US total import growth rate, with significant increase in the US export market share, indicating increasing importance to the US.

During the two periods of time from 1996~1998 and from 2005~2007, the number of industries that have RCA value greater than 1 for Taiwan and Japan's export to the US which means the number of industries having the above strong export competitiveness has increased, while Mainland China maintained the 36 strongest items and South Korea decreased from 21 items of industry to 19 items of industry.

Table 1: The export market share, export growth rate of Japan, China, South Korea and Taiwan's export to the US and the US total import growth rate and the analysis of RCA average value and the number of scope items

Year	Export country	$RCA \geq 2$ Number of industry	$1 \leq RCA < 2$ Number of industry	$RCA \geq 1$ Number of industry	The annual average % of the US import share occupied by export to US	Growth rate % of export to US	Total import growth rate % of the US
	Taiwan	13	11	24	3.72	10.74	15.5
	China	20	16	36	7.16	38.16	
	South Korea	8	13	21	2.71	5.68	

1996	~	Japan	3	11	14	13.94	5.78	
1998		All countries	4	/	/	27.53	14.05	
2005	~	Taiwan	13	15	28	2.03	9.98	16.75
		China	19	17	36	15.50	32.03	
		South Korea	11	18	19	2.51	8.64	
		Japan	5	13	18	7.89	5.41	
		All countries	4	/	/	27.93	29.97	
1996	~	Taiwan	/	/	/	2.88	28.05	146.89
		China	/	/	/	10.79	524.01	
		South Korea	/	/	/	2.85	109.94	
		Japan	/	/	/	10.84	26.28	
		All countries	4	/	/	27.36	152.10	

Source: Calculated by The Author.

In order to obtain the concept of the pattern change in Japan, China, South Korea, and Taiwan's export to the US from the period of 1996 to 2007, we referred to the method of Bender and Li (2002) to use the first three-year RCA average (1996~1998) and the last three-year RCA average (2005~2007) for the period of study, to calculate for each sector of the nation group, of which the average should be regarded as the real RCA index for each sector at the start and end of this period, and the changes in the sector's RCA average values can be provided as the changing index of the export pattern.

The following calculations analyze the RCA average values for 1996~1998 to be compared to the RCA average for 2005~2007:

1. Taiwan's export to the US market

- (1) The HS two-digit industries that improved by over 50% with the 2005~2007 RCA average value greater than 1 (indicating export RCA improved and having strong export competitive advantage) are: 25, 72, 93, 89, 98, 54, 85, 55, 40, 56, 70 (Table 2), especially the 4 items of industry at front were strengthened over 200%.
- (2) The HS two-digit industries that degraded by over 50% with the 1996~1998 RCA average value greater than 1 (indicating having strong export competitiveness during 1996~1998, but the export RCA was degraded during 2005~2007) are: 42, 63, 66, 94 (Table 2), and these industrial items need to be focused on.
- (3) The HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007 RCA average value all greater than 2 (indicating the industrial items maintained extremely strong export competitiveness advantage) are: 55, 58, 60, 65, 73, 82, 83, 92 (Table 3).

2. Mainland China's export to the US market

- (1) The HS two-digit industries that improved by over 50% with the 2005~2007 RCA average value greater than 1 are: 86, 84, 49, 70, 55, 73 (Table 2).
- (2) The HS two-digit industries that degraded by over 50% with the 1996~1998 RCA average value greater than 1 are: 57, 50, 91, 67, 36 (Table 2).
- (3) The HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007 RCA average value all greater than 2 are: 5, 42, 43, 46, 63, 64, 65, 66, 67, 92, 94, 95, 96 (Table 3), indicating the industrial items maintained extremely strong export competitiveness advantage.

Table 2: Analysis of the 1996~1998 RCA average value and the 2005~2007

RCA average value of Taiwan, mainland China's export to the US market

Taiwan's export to the US market				Mainland China's export to the US market			
HS	1996~1998 RCA average value (a)	2005~2007 RCA average value (b)	Variation rate (b-a)/a	HS	1996~1998 RCA average value (a)	2005~2007 RCA average value (b)	Variation rate (b-a)/a
25 Salt; sulphur; earth and stone; plastering materials, lime and cement	0.0167	1.4111	83.6650	86 Railway or tramway locomotives, rolling-stock & parts thereof; track fixtures fittings & parts thereof; mechanical traffic signaling equipment	0.1642	1.2222	6.4428
72 Iron and steel	0.3294	1.8141	4.5073	84 Nuclear reactors, boilers, machinery and mechanical appliances; part thereof	0.5807	1.6097	1.7721
93 Arms and ammunition; parts and accessories thereof	0.6488	2.0340	2.1350	49 Printed books, newspaper, pictures & other products of the printing industry; manuscripts, typescripts & plans	0.6946	1.8659	1.6864
89 Ships, boats and floating structures	1.5214	4.7667	2.1331	70 Glass and glassware	0.7664	1.3881	0.8112
98 Articles of Special Trade and Good Unclassified	0.3809	1.0654	1.7972	55 Man-made staple fibres	0.6210	1.0833	0.7445
54 Man-made filaments	0.9103	2.0585	1.2614	73 Articles of iron or steel	1.1583	1.8457	0.5935
85 Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers	1.6658	2.9795	0.7886	57 Carpets and other textile floor coverings	2.5051	1.0581	-0.5776
55 Man-made staple fibres	2.0719	3.5694	0.7228	50 Silk	3.7778	1.6667	-0.5588
40 Rubber and articles thereof	0.8673	1.4862	0.7136	91 Clocks and watches and parts thereof	2.2242	1.0708	-0.5186
56 Wadding, felt and nonwovens; special yarns; twine, cordage ropes and cables and articles thereof	0.7024	1.125	0.6017	67 Prepared feathers & down & articles made of feathers or of down artificial flowers; articles of human hair	11.3333	5.625	-0.5037
70 Glass and glassware	0.7751	1.1743	0.5150				
42 Articles of leather; saddlery & harness; travel goods, handbags, articles of animal gut	1.1154	0.3614	-0.6760				
63 Other products made of textile articles; sets; worn clothing and worn textile articles; rags	1.6984	0.6111	-0.6402				
66 Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof	2.4444	1	-0.5909				

94 Furniture; bedding & similar stuffed furnishings; lamps & lighting fittings; illuminated signs, illuminated name-plates & the like; prefabricated buildings	2.3625	1.0467	-0.5570				
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Source: Calculated by the author.

Table 3: The analysis of the HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007

RCA average value greater than 2 of Taiwan, mainland China's export to the US market

Taiwan's export to the US market			Mainland China's export to the US market		
HS	1996 ~ 1998 RCA average value	22005 ~ 2007 RCA average value	HS	1996 ~ 1998 RCA average value	22005 ~ 2007 RCA average value
55 Man-made staple fibres	2.0719	3.5694	5 products of animal origin, not elsewhere specified or included	3.3333	2.5833
58 Special woven fabrics; tufted textile fabrics; lace; tapestries trimmings; embroidery	6.3889	6.5833	36 Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations	5.3333	2.6667
60 Knitted or crocheted fabrics	6.9345	5.1222	42 Raw hides and skins(other than fur skins)	6.9933	4.6453
65 Headgear and parts thereof	4.4697	2.375	43 Fur skins and artificial fur; manufactures thereof	2.2222	2.2778
73 Articles of iron or steel	3.1415	3.4321	46 Manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork	9.8889	5.2222
82 Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal	3.7023	4.4722	63 Other products made of textile articles; sets; worn clothing and worn textile articles; rags	3.4458	2.9877
83 Miscellaneous articles of base metal	3.9780	3.9715	64 Footwear, gaiters and the like; parts of such articles	7.4940	4.6739
92 Musical instruments, parts and accessories of such articles	2.3590	3.5053	65 Headgear and parts thereof	3.3758	3.9213
			66 Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof	8.6667	6.3333
			67 Prepared feathers & down & articles made of feathers or of down artificial flowers; articles of human hair	11.3333	5.625
			92 Musical instruments, parts and accessories of such articles	2.6667	2.4901
			94 Furniture; bedding & similar stuffed furnishings; lamps & lighting fittings; illuminated signs, illuminated name-plates & the like; prefabricated buildings	3.0190	3.0945
			95 Toys, games and sports requisites; part and accessories thereof	7.9050	5.2275
			96 Miscellaneous manufactured articles	2.8618	2.8855

Source: Calculated by the author.

3. South Korea's export to the US market

(1) The HS two-digit industries that improved by over 50% with the 2005~2007 RCA average value greater than 1 are: 25, 89, 87, 52, 40 (Table 4). Among them, Taiwan also improved export competitiveness with strong export competitiveness advantage for the "25", "89", "40" industries.

(2) The HS two-digit industries that degraded by over 50% with the 1996~1998 RCA average value greater than 1 are: 54, 55, 60, 85, 92 (Table 4).

Among them, Taiwan also faced the same situation for the "42", "63" industries.

(3) The HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007 RCA average value all greater than 2 are: 54, 55, 60, 85, 92 (Table 5).

Among them, Taiwan also maintain extremely strong export competitiveness advantage for "55", "60", "92" industries.

4. Japan's export to the US market

(1) The HS two-digit industries that improved by over 50% with the 2005~2007 RCA average value greater than 1 are: 65, 86, 81, 87, 37, 38 (Table 4).

(2) The HS two-digit industries that degraded by over 50% with the 1996~1998 RCA average value greater than 1 are: 70 (Table 4).

(3) The HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007 RCA average value all greater than 2 are: 37 (Table 5).

Table 4: Analysis of the 1996~1998 RCA average value and the 2005~2007

RCA average value of South Korea, Japan's export to the US market

South Korea's export to the US market				Japan's export to the US market			
HS	1996 ~ 1998 RCA average value (a)	2005 ~ 2007 RCA average value (b)	Variation rate (b-a) /a	HS	1996 ~ 1998 RCA average value (a)	2005 ~ 2007 RCA average value (b)	Variation rate (b-a) /a
25 Salt; sulphur; earth and stone; plastering materials, lime and cement	0.0828	1.4667	16.7125	65 Headgear and parts thereof	0.1879	1.0185	4.4211
89 Ships, boats and floating structures	0.1735	2.0083	10.5751	86 Railway or tramway locomotives, rolling-stock & parts thereof; track fixtures fittings & parts thereof; mechanical traffic signaling equipment	0.3121	1.2222	2.9162
87 Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	0.6509	2.0066	2.0830	81 Other base metals; cermets; articles thereof	0.6810	1.4419	1.1175
52 Cotton	1.1727	3.3357	1.8444	87 Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	1.9461	3.3008	0.6961
40 Rubber and articles thereof	1.3041	2.2204	0.7026	37 Photographic or cinematographic goods	3.2938	5.4317	0.6491
42 Articles of leather; saddlery & harness; travel goods, handbags, articles of animal gut	1.5508	0.1163	-0.9250	38 Miscellaneous chemical products	1.7283	2.6413	0.5283

67 Prepared feathers & down & articles made of feathers or of down artificial flowers; articles of human hair	1.7667	0.2202	-0.8753	70 Glass and glassware	1.0325	0.5043	-0.5115
62 Articles of apparel and clothing accessories, no knitted or crocheted	1.3258	0.2985	-0.7748				
63 Other made up textile articles; sets; worn clothing and worn textile articles; rags	1.0828	0.2963	-0.7264				
92 Musical instruments, parts and accessories of such articles	4.9744	2.1528	-0.5672				
96 Miscellaneous manufactured articles	1.7445	0.8488	-0.5135				

Source: Calculated by the author.

Table 5: The analysis of the HS two-digit industries with the 1996~1998 RCA average value and the 2005~2007 RCA average value greater than 2 of South Korea, Japan's export to the US market

South Korea's export to the US market			Japan's export to the US market		
HS	1996 ~ 1998 RCA average value	22005 ~ 2007 RCA average value	HS	1996 ~ 1998 RCA average value	22005 ~ 2007 RCA average value
54 Man-made filaments	6.3241	3.8258	37 Photographic cinematographic goods	3.2938	5.4317
55 Man-made staple fibres	3.7138	4.9676			
60 Knitted or crocheted fabrics	8.0317	9.7111			
85 Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers	2.5971	2.3125			
92 Musical instruments, parts and accessories of such articles	4.9743	2.1528			

Source: Calculated by The Author.

Summary of the above analysis of real evidence indicates the existence of the strengthening and weakening relationship between each country's RCA variations.

Analysis of the correlation coefficients between industries for the change of export patterns to find out if they are related to the shifting of regional comparative advantage – exploration of the industries in Japan, China, South Korea, and Taiwan that export to the US market by competition or shifting market

The study employed the Clark et. al (2005) method that if a certain regional industry's RCA value becomes smaller while it becomes larger in another region, the correlation coefficient significantly shows the happening of shifting effect of export comparative advantage. If certain industries in certain regions obtain comparative advantage at the same time and become more competitive, and the correlation coefficients also show significant positive correlation, it represents that these industries are to a certain degree competing between each other in these regions. *The sectors in the US market where Japan's are replaced by Taiwan's and Korea's or Taiwan's and South Korea's are replaced by Mainland China's*

When comparing between Japan, China, South Korea and Taiwan from 1996~1998 and 2005~2007, many sectors experienced opposite direction of changes in RCA values. If, when Japan lost comparative advantage in certain industries while Taiwan or Korea gained comparative advantage and became more competitive (2005~2007 RCA average value greater than 1), meanwhile for 12 years from 1996~2007 the Corr (Taiwan, Japan) or Corr (Taiwan,

South Korea) were negative under 0.05 significance level, then we may conclude that the comparative advantages of Japan's export to the US were to a certain degree shifted to Taiwan and South Korea. According to this standard, we also find Taiwan and South Korea's comparative advantages to a certain degree were shifted to Mainland China's industries (Table 6).

Table 6: Analysis of the industries that the comparative advantages of Japan's exports to the US were to a certain degree shifted to Taiwan and South Korea, or the comparative advantages of Taiwan and South Korea's to a certain degree were shifted to Mainland China

In the US Market						
The industries of Japan's with their comparative advantages to a certain degree shifted to Taiwan		The industries of Japan's with their comparative advantages to a certain degree shifted to South Korea	The industries of Taiwan's with their comparative advantages to a certain degree shifted to Mainland China		The industries of South Korea's with their comparative advantages to a certain degree shifted to Mainland China	
HS	Corr (Taiwan, Japan) _{1996~2007}	None	HS	Corr (Taiwan, China) _{1996~2007}	HS	Corr (China, South Korea) _{1996~2007}
54 (Man-made filaments)	-0.656*	None	65 (Headgear and parts thereof)	-0.720**	73 (Articles of iron or steel)	-0.591*
70 (Glass and glassware)	-0.850**		84 (Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof)	-0.618*		
85 (Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers)	-0.804**					

*: under 0.05 significance level; **: under 0.01 significance level
Source: Calculated by The Author.

The industries in the US market where Japan's are competing with Taiwan's and South Korea's, and Taiwan's and South Korea's are competing with Mainland China's

When comparing between Japan, China, South Korea and Taiwan from 1996~1998 and 2005~2007, many industries experienced the same direction of changes in RCA values. When certain industries of Japan's and Taiwan's or South Korea's gained comparative advantages at the same time and became more competitive (2005~2007 RCA average value greater than 1), meanwhile for 12 years from 1996~2007 the Corr (Taiwan, Japan) or Corr (Taiwan, South Korea) were positive under 0.05 significance level, then we may conclude that these sectors of Japan's in the US market were to a certain degree competing with Taiwan's and South Korea's. According to this standard, we also find the industries of Taiwan's and South Korea's in the US market to a certain degree were competing with Mainland China's (Table 7).

Table 7: The analysis of the industries in the US market where Japan's are competing with Taiwan's and South Korea's or Taiwan's and South Korea's are to certain degree competing with Mainland China's

In the US market							
The industries of Japan's that are to a certain degree competing with the Taiwan's		The industries of Japan's that are to a certain degree competing with the South Korea's		The industries of Taiwan's that are to a certain degree competing with the mainland China's		The industries of South Korea's that are to certain degree competing with Mainland China's	
HS	Corr (Taiwan,Japan) 1996~2007	HS	Corr (South Korea, Japan) 1996~2007	HS	Corr (Taiwan,China) 1996~2007	HS	Corr (China, South Korea) 1996~2007
40 (Rubber and articles thereof)	0.927**	40 (Rubber and articles thereof)	0.777**	70 (Glass and glassware)	0.621*	55 (Man-made staple fibres)	0.704*
99 (Special commodities not classified)	0.943**	87 (Vehicles other than railway or tramway rolling-stock, parts and accessories thereof)	0.943**	85 (Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers)	0.973**		

*: under 0.05 significance level; **: under 0.01 significance level

Source: Calculated by The Author.

Using correlation coefficients to explore the scale of industrial structure change in the same region, and the correlation of development pattern in different regions to be following development in or competing with each other

In the same region, if the correlation coefficients of RCA values from period 0 to period t are high, it indicates the industrial structure change is small from period 0 to period t; conversely, if the correlation coefficients are low, it indicates the industrial structure change is large. In different regions, if the correlation coefficients of RCA values from period 0 to period t are high, then it indicates that the industrial comparative advantage development pattern in a certain region is following another region. There are significant positive correlations between South Korea and Taiwan's export products to the US market (Table 8), representing that the two countries are competing with each other, and the movement changes of the two countries' industries are also considerably consistent. In the same period, the patterns of export to the US between Taiwan and Mainland China, Japan, and between Mainland China and Japan are rather not correlated.

Table 8: Analysis of the correlation coefficients for RCA values of export to the US between Taiwan and China, South Korea, Japan, and China and Japan

Country \ Year	Taiwan/China	Taiwan/South Korea	Taiwan/Japan	China/Japan
1996	0.202*	0.524**	0.169	-0.102
1997	0.172	0.650**	0.175	-0.079
1998	0.143	0.636**	0.183	-0.083
1999	0.152	0.640**	0.183	-0.126
2000	0.163	0.554**	0.185	-0.075
2001	0.118	0.546**	0.171	-0.051
2002	0.152	0.620**	0.165	-0.081
2003	0.155	0.662**	0.177	-0.092
2004	0.181	0.631**	0.203*	-0.056
2005	0.194	0.686**	0.177	-0.065

2006	0.191	0.555**	0.189	-0.091
2007	0.200*	0.501**	0.198	-0.057

*: correlation coefficient under 0.05 significance level; **: correlation coefficient under 0.01 significance level; Source: Calculated by the author.

The pattern of Taiwan's 2007 export to the US was rather similar to the pattern of Japan's 1996 export to the US, indicating Taiwan's export pattern followed Japan's and has not developed at the same pace as Japan's (Table 9).

Table 9: Analysis of the correlation coefficients for RCA values of export to the US between Taiwan, South Korea of 2007 and Japan from 1996~2007

Year \ Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Taiwan of 2007 versus Japan of each year	0.29**	0.27**	0.26*	0.25*	0.24*	0.23*	0.21*	0.21*	0.21*	0.17	0.19	0.20
South Korea of 2007 versus Japan of each year	0.19	0.17	0.18	0.19	0.17	0.16	0.15	0.18	0.19	0.18	0.21*	0.19

*: correlation coefficient under 0.05 significance level; **: correlation coefficient under 0.01 significance level; Source: Calculated by the author.

Mainland China's pattern of export to the US follows Taiwan and its correlation coefficient of RCA value of 2007 with Taiwan of 1996 is 0.44, which indicates that Mainland China is following closely the development route of Taiwan closely to move forward. The correlation coefficient of RCA value for export to the US between Mainland China of 2007 and South Korea of 1996 is 0.23, which indicates that the pattern of export products to the US between Mainland China of 2007 and South Korea of 1996 is to a certain degree similar (Table 10).

Table 10: Analysis of the correlation coefficients for RCA values of export to the US between Mainland China in 2007 and Taiwan, South Korea from 1996~2007

Year \ Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Mainland China of 2007 versus Taiwan of each year	0.44**	0.39**	0.36**	0.34**	0.34**	0.29**	0.27**	0.25*	0.26*	0.22*	0.20*	0.20*
Mainland China of 2007 versus South Korea of each year	0.23*	0.18	0.18	0.18	0.16	0.14	0.12	0.06	0.03	0.02	0.03	0.01

*: correlation coefficient under 0.05 significance level; **: correlation coefficient under 0.01 significance level; Source: Calculated by the author.

In summary of the correlation coefficients of RCA values of export to the US from 2007 to 1996 for Japan, China, South Korea and Taiwan to observe the scale of export structure change for each country's industries; if the correlation coefficients are small, it represents the industrial export structure change is large. It is worth mentioning that this is derived from Table 11: the industrial correlation coefficient was only 0.36 for Korea's export to the US from 1996 to 2007, which indicates that this country has a certain degree of change in the content of export products to the US during that 12-year period.

Table 11: Analysis of the correlation coefficient of RCA of export to the US market for Taiwan, China, South Korea and Japan of 1996 versus 2007

Year \ Country	Taiwan	Mainland China	South Korea	Japan
1996 versus 2007	0.80**	0.90**	0.36**	0.87**

** : correlation coefficient under 0.01 significance level

Source: Calculated by the author.

CONCLUSIONS AND SUGGESTIONS

Conclusions

In summary of the above, the enhancement of RCA values can be deemed as the improvement of industrial export competitiveness, therefore the conclusions of this study are specifically illustrated as follows:

1. In terms of “the exploration of RCA variation to analyze the enhancement rate and reducing rate”:

During 1996~1998 and 2005~2007, the number of Taiwan’s industries with their RCA values of export to the US greater than 1, i.e. the industries having above strong export competitiveness increased from 24 to 28 items of industry; while Japan increased from 14 to 18 items of industry; and China maintained 36 strong items, however South Korea decreased from 21 to 19 items of industry.

2. It is found for “using RCA values to inspect whether the changes of export pattern were correlated to the shifting of regional comparative advantages”

(1) The sectors of Japan’s which were to a certain degree replaced by Taiwan’s: HS54 (Man-made filaments), HS70 (Glass and glassware), HS85 (Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers).

(2) The sectors of Taiwan’s which were to a certain degree replaced by Mainland China’s: HS65 (Headgear and parts thereof), HS84 (Nuclear reactors, boilers, machinery and mechanical appliances; part thereof).

(3) The sectors of South Korea’s which were to a certain degree replaced by Mainland China’s: HS73 (Articles of iron or steel).

(4) The sectors of Japan’s which were to a certain degree competing with Taiwan’s: HS40 (Rubber and articles thereof), HS99 (Special commodities not classified).

(5) The sectors of Japan’s which were to a certain degree competing with South Korea’s: HS40 (Rubber and articles thereof), HS87 (Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof).

(6) The sectors of Taiwan’s which were to a certain degree competing with Mainland China’s: HS70 (Glass and glassware), HS85 (Electrical machinery & equipment & parts thereof; sound recorders & reproducers, television image & sound recorders & reproducers).

(7) The sectors of South Korea’s which were to a certain degree competing with Mainland China’s: HS55 (Man-made staple fibres).

3. It is found for “using RCA correlation coefficients to explore whether the changes of export patterns in the same region or different regions were correlated”

(1) There is significant positive correlation between the products of South Korea and Taiwan’s exports to the US, which indicates that the two countries are competing with each other and the two countries’ industrial movement changes are also considerably consistent.

(2) Taiwan follows Japan in its pattern of export to the US but has not developed at the same pace with Japan yet.

(3) Mainland China follows Taiwan in its pattern of export to the US, and it follows Taiwan’s development route closely to move forward.

(4) Since 1996, the product structure of South Korea’s export to the US has changed to a certain degree.

Suggestions

In summary of the above analysis, the enhancement of RCA values can be deemed as the improvement of industrial export competitiveness, which could be further analyzed into more detailed items of products for the effectiveness of trade as future study. It is hoped that this article can be helpful for the understanding of the trade relationship between Taiwan and each competing countries, as well as the changing trends of Taiwan’s export competitiveness.

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